CLAIMS

What is claimed is:

1. A method of detecting and/or processing signal waves which in an article sensitive to the signal waves produce charge carriers which induce a signal current in at least one readout electrode, wherein there are provided at least two modulation electrodes, at least one of which is arranged in spatial proximity with the at least one readout electrode and the other modulation electrode is arranged in spatial proximity either with the same readout electrode or a further readout electrode in such a way that in dependence on the sign of the modulation voltage of the respective modulation electrode the current flowing by way of the associated readout electrode is positive or negative, characterized in that the modulation electrodes are modulated with a voltage amplitude and/or phase relationship which can be freely selected relative to each other, wherein the readout currents produced by the modulation voltages of both modulation electrodes are additively coupled.

2. A method according to claim 1 characterized in that the spatial arrangement of the modulation electrodes relative to the readout electrodes and/or the voltage amplitudes of the modulation voltages are so selected that with opposite signs of the modulation voltages the added readout currents mutually cancel each other out.

3. A method according to claim 1 or claim 2 characterised in that one of the modulation voltages is a constant voltage while the other is of a freely selectably alternating sign.

4. A method according to one of claims 1 to 3 characterised in that the amplitudes of the modulation voltages are variable.

5. A method according to one of claims 1 to 4 characterised in that a plurality of different signal currents which are produced by different signal waves on separate elements are combined together, in particular added.

6. A method according to one of claims 1 to 5 wherein the signal waves are also modulated and modulations of the modulation electrodes are in well-defined relationship with the modulation of the signal waves.

7. A method according to claim 6 characterised in that the readout electrodes and the modulation electrodes are used as PMD elements insofar as both modulation electrodes experience in in-phase relationship a fast change in sign of the modulation voltage and the readout current is integrated over at least one such period.

8. A method according to claim 6 wherein the readout electrodes and modulation electrodes are operated by changing the phase and/or amplitude relationships of the modulation signals alternately or parallel as PMD elements and/or OEP elements, wherein preferably the OEP elements in an array which are operable selectively by spatially

alternating modulation conditions MZP and MZN implement pattern analysis or position frequency analysis of signal waves.

9. A method according to one of claims 1 to 8 characterised in that the interlinking of readout signals of various readout electrodes includes in particular addition, subtraction or addition with variably adjustable phase relationship and logical interlinkings AND, OR, XOR and the negations thereof.

10. A method according to one of claims 1 to 9 characterised in that the optoelectronic processor OEP which preferably has a low level of substrate doping, by means of control by three matched modulation voltage conditions, provides three associated readout current conditions, a first modulation condition MZP (UMaP, UMbP) with a positive, preferably maximum readout current IAP, a second modulation condition MZN (UMaN, UMbN) with a negative, preferably minimum readout current IAN and a third modulation condition MZ0 (UMaP, UMbN) or MZ0 (UMaN, UMbP) respectively with a vanishing readout current IA0 = 0.

11. A method according to one of claims 1 to 10 characterised in that integration of the readout current IAS is effected and in which zero switching of the integrated readout current or the readout charge QS is effected in that, preferably after preceding zero switching of the charge QS, high-frequency symmetrical switching-over of the two modulation conditions MZP and MZN occurs.

12. A method according to one of claims 1 to 11 characterised in that the OEP strip structures have avalanche semiconductor structures, use ionisation effects of fast electrons or are connected to electron multipliers, in which in particular the charge carriers produced by the signal wave or the readout currents are amplified by multiplication, on the one hand by the avalanche effect by suitably biased pn- or Schottky junctions in the semiconductor substrate, wherein the modulation voltages are preferably regulated in respect of amplitude, further by upstream connection of a photocathode and by secondary electron multiplication of the photoelectrons in vacuum by means of micro-channel plates or photomultipliers, wherein either the electron image is firstly converted back into an optical image or is read out directly by the OEP structure, wherein in the latter case the secondary photoeffects of the high-energy electrons in the OEP substrate involves a considerable charge carrier multiplication.

13. A method according to one of claims 1 to 11 characterised in that the photoelectrons of the photocathode are image-formingly accelerated without using a micro-channel plate directly onto the OEP surface and by virtue of ionisation and charge carrier generation permit a high level of amplification which can be easily regulated by way of the acceleration voltage.

14. Apparatus for detecting and processing signal waves, with an article OEP which is sensitive to the signal waves and in which the signal waves produce charge carriers, and at least one readout electrode (AK) connected to the charge carrier region of the article, wherein there are provided at least two modulation electrodes (MKa, MKb) of which at least

one is arranged in spatial proximity with the at least one readout electrode (AK) and the other is arranged in spatial proximity either with the same readout electrode (AK) or a further readout electrode (AK2), characterised in that the modulation electrodes are arranged relative to the readout electrode or electrodes in such a way that in dependence on the sign of the modulation voltages of the respective modulation electrodes the current flowing by way of the associated readout electrode is positive or negative and that there is provided at least one device by which the relative phase relationship and/or the voltage amplitude of the two modulation voltages can be freely set.

15. Apparatus according to claim 14 characterised in that the photosensitive article is a photosensitive semiconductor material.

16. Apparatus according to claim 14 characterised in that the photosensitive article is a photocathode, provided with modulation electrodes suitable for operation in vacuum for modulation of the photoelectrons in relation to suitably designed readout electrodes in at least one single OEP or twin OEP structure, wherein the readout electrodes are preferably provided with an upstream-connected secondary electron multiplication means, preferably in the form of micro-channel plate elements, and wherein the readout current is read out with an anode readout structure or with a suitably adapted CCD or CMOS or MSM camera chip structure.

17. Apparatus according to one of claims 14 and 15 characterised in that the readout and modulation electrodes are metal semiconductor contacts or Schottky diodes.

18. Apparatus according to one of claims 14 to 17 characterised in that the readout electrodes (AK, AK1, AK2) and at least one respective modulation electrode (MKa) interengage comb-like, wherein the readout electrode is connected to a further readout electrode designed in the same manner, which interengages comb-like with the second modulation electrode (MKb).

19. Apparatus according to one of claims 14 to 18 characterised in that a plurality of mutually independent readout electrodes and associated modulation electrodes are arranged in an array.

20. Apparatus according to one of claims 14 to 19 characterised in that there are provided devices for modulation of the signal wave or waves.

21. Apparatus according to one of claims 14 to 20 characterised in that an OEP structure is in the form of a PLL or DLL circuit, more specifically preferably in the form of an array, for example in a router, and/or that there is provided a PLL or DLL input circuit for detecting signal modulation or encoding and for adapting the modulation frequency and the phases of modulation of the modulation electrodes to the signal wave modulation.

22. Apparatus according to one of claims 14 to 21 characterised in that the strip-shaped modulation and readout electrodes of the optoelectronic processor OEP are embodied by metal electrodes as Schottky contacts, preferably of a width of 0.1 – 5 μm, on a sensitive semiconductor substrate 3 adapted to the signal wave, preferably a high-ohmic (p^-)- or (n^-)-substrate or a high-ohmic (p^-)- or (n^-)-epitaxial layer, preferably with intermediate spaces of approximately the same to multiple width and preferably of a thickness adapted to the depth of penetration of the signal wave, wherein the substrate 3 is preferably at free potential (floating substrate).

23. Apparatus according to one of claims 14 to 22 characterised in that the strip-shaped modulation electrodes M and readout electrodes A are embodied by (n^+)- and (p^+)-strips or channels, for example of a width in the approximately 0.1 to 5 μm range, on a sensitive semiconductor substrate adapted to the signal wave or the epitaxial layer 3, preferably an intrinsically conducting to high-ohmic (p^-)- or (n^-)-substrate respectively which preferably with the strip electrodes forms blocking PN junctions with a deeply extended space charge zone and preferably with intermediate spaces approximately of the same to multiple width.

24. Apparatus according to one of claims 14 to 23 characterised in that in each case the electrodes M and/or A are covered by preferably insulated screening metal electrodes of suitable width and are preferably capacitively coupled to modulation sources, wherein the M-screening metal electrodes and the A-screening metal electrodes are preferably connected to push-pull modulation sources.

25. Apparatus according to one of claims 14 to 24 characterised in that the readout unit VAEH of the single OEP with the inherently contained interlinking of the readout currents involves influence regions of the at least two modulation voltages or the interlinking and readout unit VAEH of the multiple OEP is in the form at the input side of a low-ohmic current readout circuit.

26. Apparatus according to one of claims 14 to 25 characterised in that the current readout circuit of the partial OEPs is individually or group-wise in the form of direct current summing corresponding to the wired-OR principle, preferably with subsequently single Miller integrator for correlation applications or in which for example two partial OEPs are read out by a differential Miller integrator, wherein the polarity of the modulation voltages is taken into consideration for those modulation conditions MZP (positive/negative), MZN (negative/positive) and MZ0 (both positive or both negative) with respect to the wired-OR summing.

27. Apparatus according to one of claims 14 to 26 characterised in that the OEP structure or the OEP functionality is effected in metal electrodes (ME)-pn technology or in Schottky technology with a semiconductor substrate 3 adapted to the wavelength range of the signal wave, for example of Si, preferably CMOS technology, GeSi quantum well structures, GaAs, InGaAsP, InSb, HgCdTe etc. as a preferably high-ohmic n-substrate or p-substrate.

28. Apparatus according to one of claims 14 to 27 characterised in that capacitive crosstalk of a high-frequency modulation signal from the modulation electrodes to the readout electrodes and to the readout terminal AK is suppressed by suitable capacitive compensation with a suitable push-pull voltage.

29. Apparatus according to one of claims 14 to 28 characterised in that the twin or quadruple OEPs are enlarged to an OEP matrix of the size M x N, wherein M and N are integers greater than 1.

30. Apparatus according to one of claims 14 to 29 characterised in that a readout electrode group for example at the readout terminal AK has a capacitance CA in relation to earth and is connected preferably to a transimpedance amplifier, with an ohmic transimpedance for logic and mixing applications and a capacitive transimpedance as a Miller integrator for correlation applications, wherein the latter circuit has at least one reset switch, and wherein preferably the same terminal AK is connected by way of a suitable capacitor CK for compensation of the crosstalk of the modulation electrodes to the readout electrodes to a voltage which is complementary in relation to the respective modulation voltage.

31. Apparatus according to one of claims 14 to 30 characterised in that the OEP structures on the side of the incident signal wave are provided with anti-reflective coatings and preferably having regard to the partial OEPs with microlenses and are preferably provided with reflective layers on the opposite side, and that the signal source SQ and the OEP receiving device are each provided with a suitable optical means.